# Research on Detection and Assessment
# Gas Technology Institute

Pipeline Research and
Development Forum

Washington, DC

11 December 2003

Albert Teitsma
Program Manager
Pipeline Operations Technology
Gas Operations Technology

# Three Types of Pipeline Threats

**Static**

Manufacturing related defects

Welding/Fabrication related

**Time Dependent**

Corrosion related

Environmental cracking

**Random**

Third party damage

Incorrect operation

Outside force

# Technologies for Pipeline Integrity

- Geometry pigs

- Low and high resolution MFL (magnetic flux leakage)
- Circumferential MFL (a.k.a. Transverse MFL)
- Ultrasonic inspection
- Ultrasonic crack detection

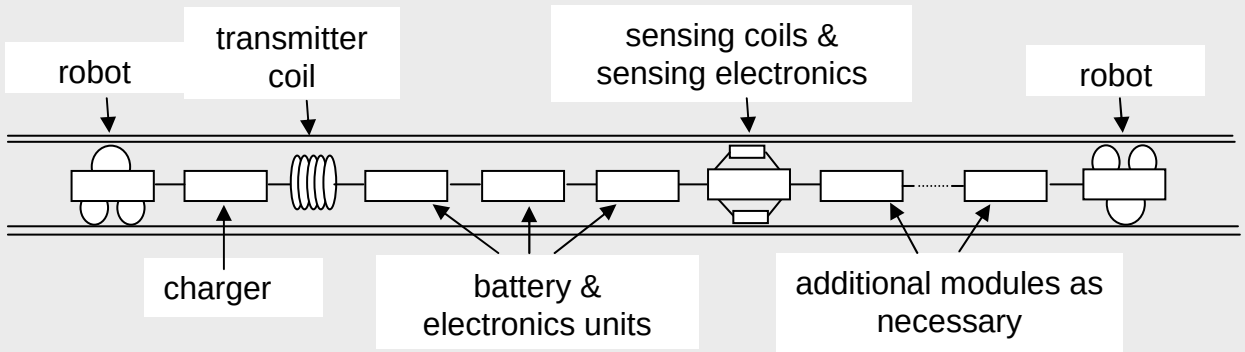
- Elastic wave vehicle
- EMAT (electromagnetic acoustic transducer)

# Technologies for Pipeline Integrity

- Some mitigating technologies coming down the pipe
  - Improvements  in in-line inspection technologies
  - Gas Coupled Ultrasonics
  - Remote Field Eddy Currents for unpiggable pipelines
  - Magnetic Telescope for unpiggable pipelines
  - NoPig
  - Mechanical damage pigs
  - Pipeline right of way management
    - Optical time domain reflectometry
    - Acoustic monitoring and impedance spectroscopy
  - Smart Pipe

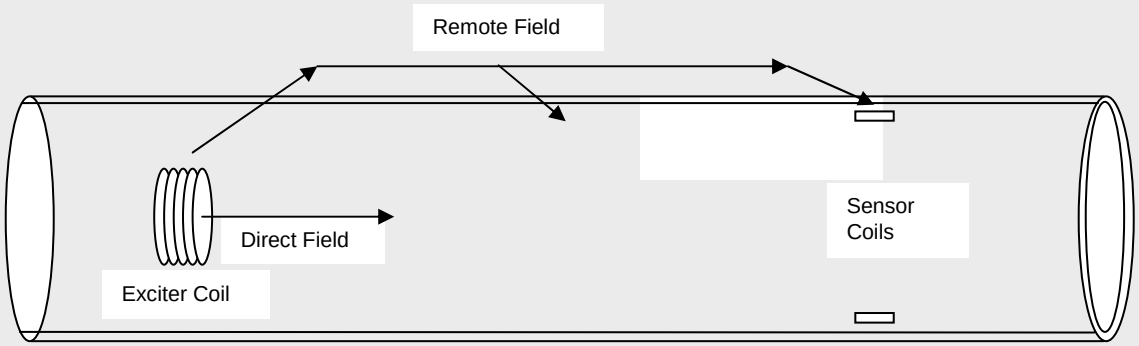
gti

# RFEC Inspection Vehicle for Unpiggable Pipelines



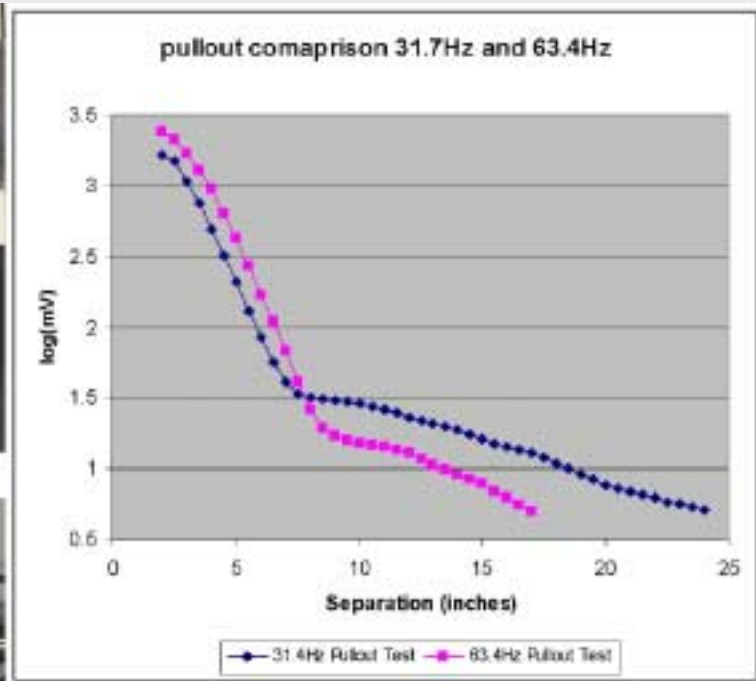

- Bypass valve and bore restrictions
- Inspect multi diameter pipes
- Go through back to back bends
- Go around tight bends and miter bends

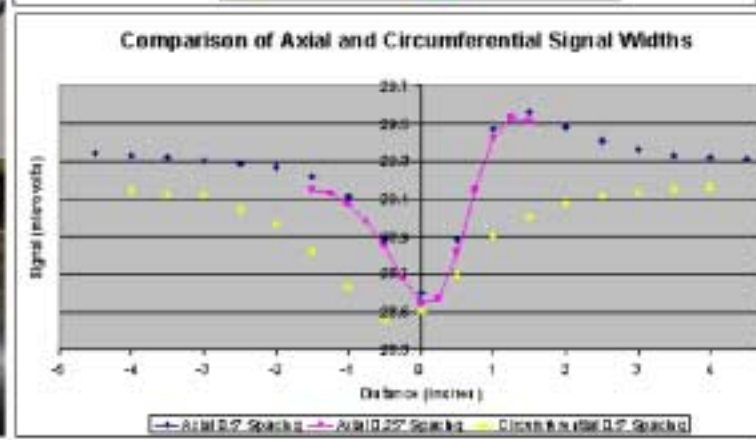
# Remote Field Eddy Current (RFEC) Inspection of Unpiggable Pipelines



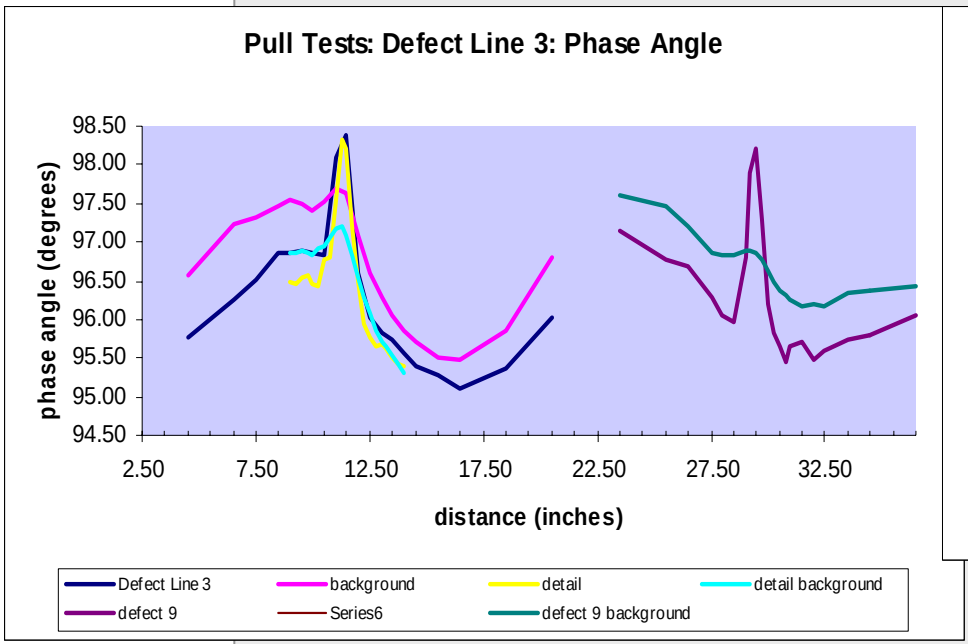

- Simple exciter coil, less than 1/3rd of pipe diameter
- Sensor array adjusts to match pipe diameter while passing small openings
- Accuracy comparable to MFL

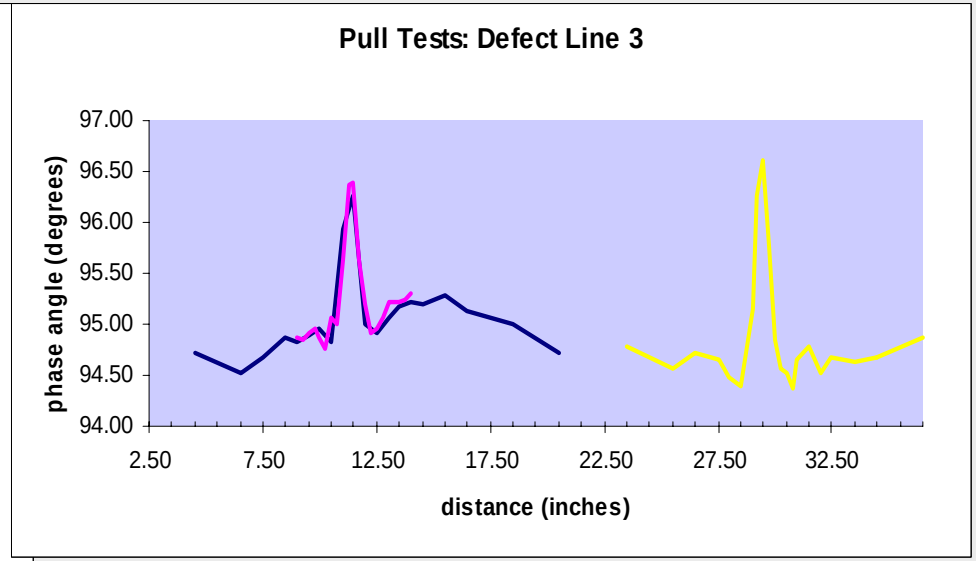
# Unpiggable Pipelines

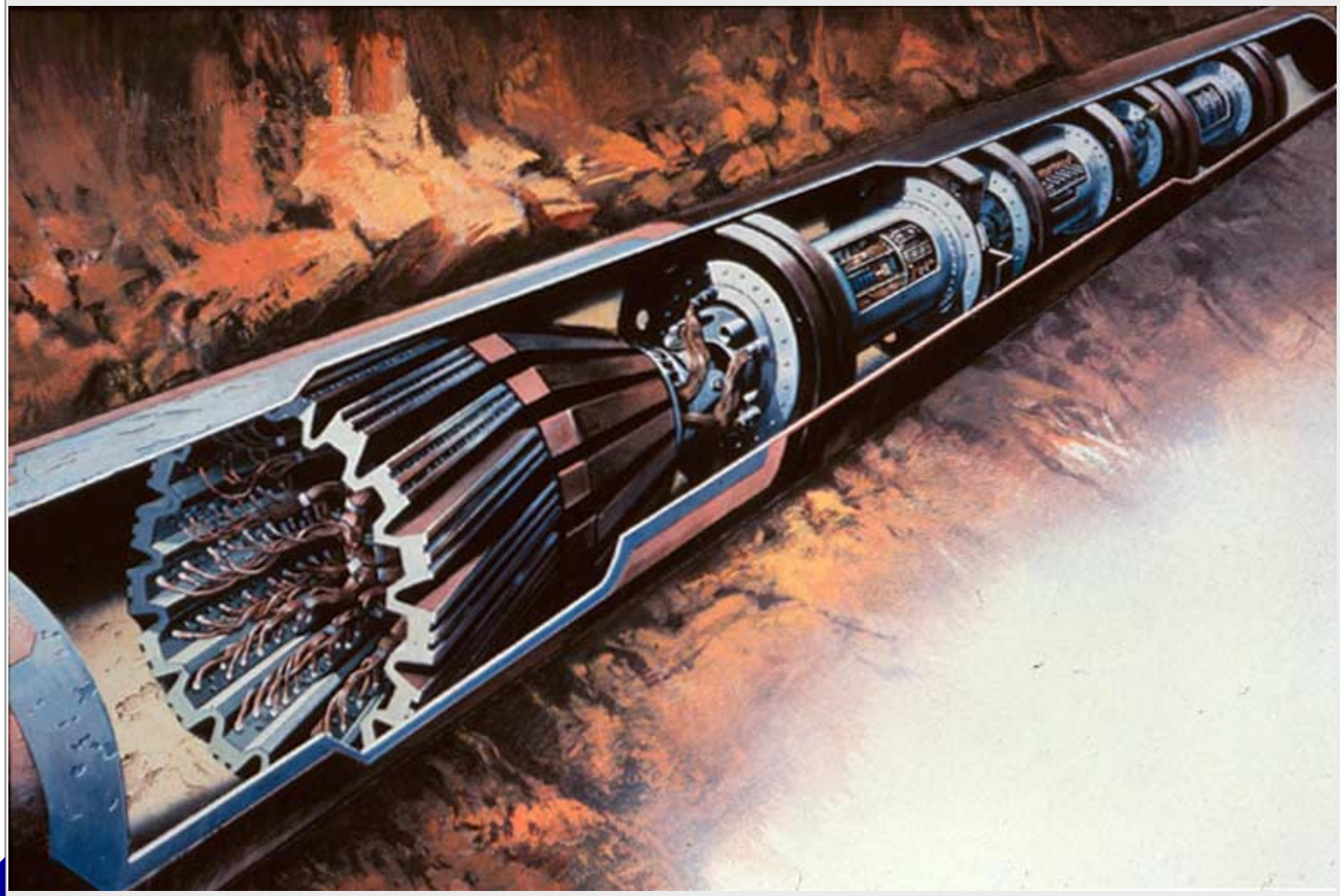



# Defect Line #3



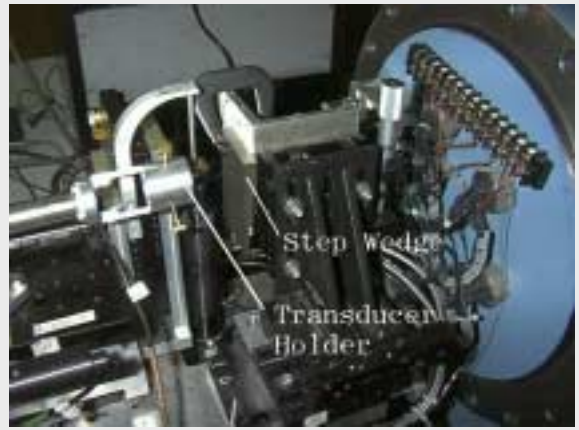



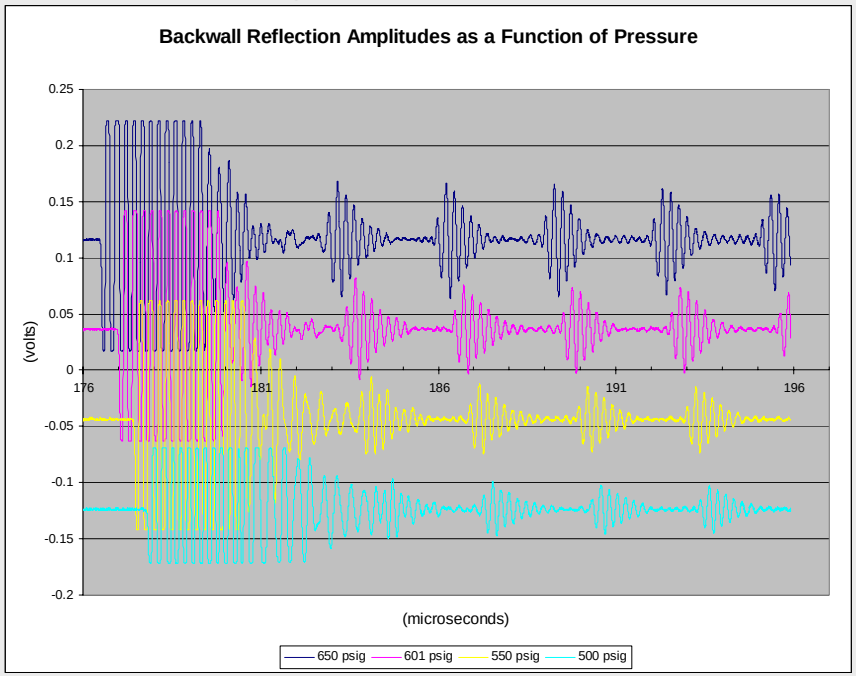
# Ultrasonic Inspection



# Gas Coupled Ultrasonics

- Direct measurement of wall thickness to a couple of percent
- Direct measurement of crack depths
- Already in use for non contact monitoring of burn victims

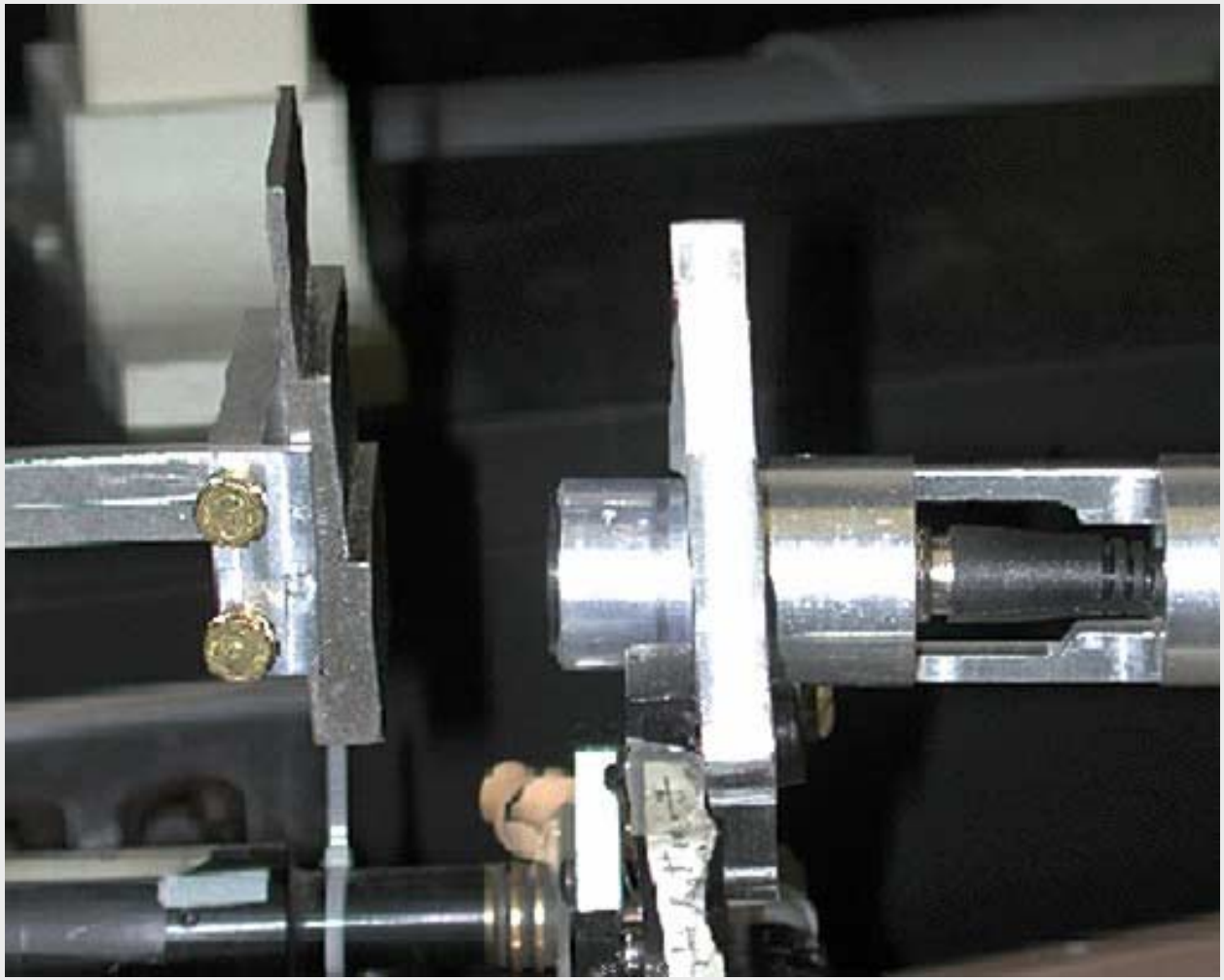


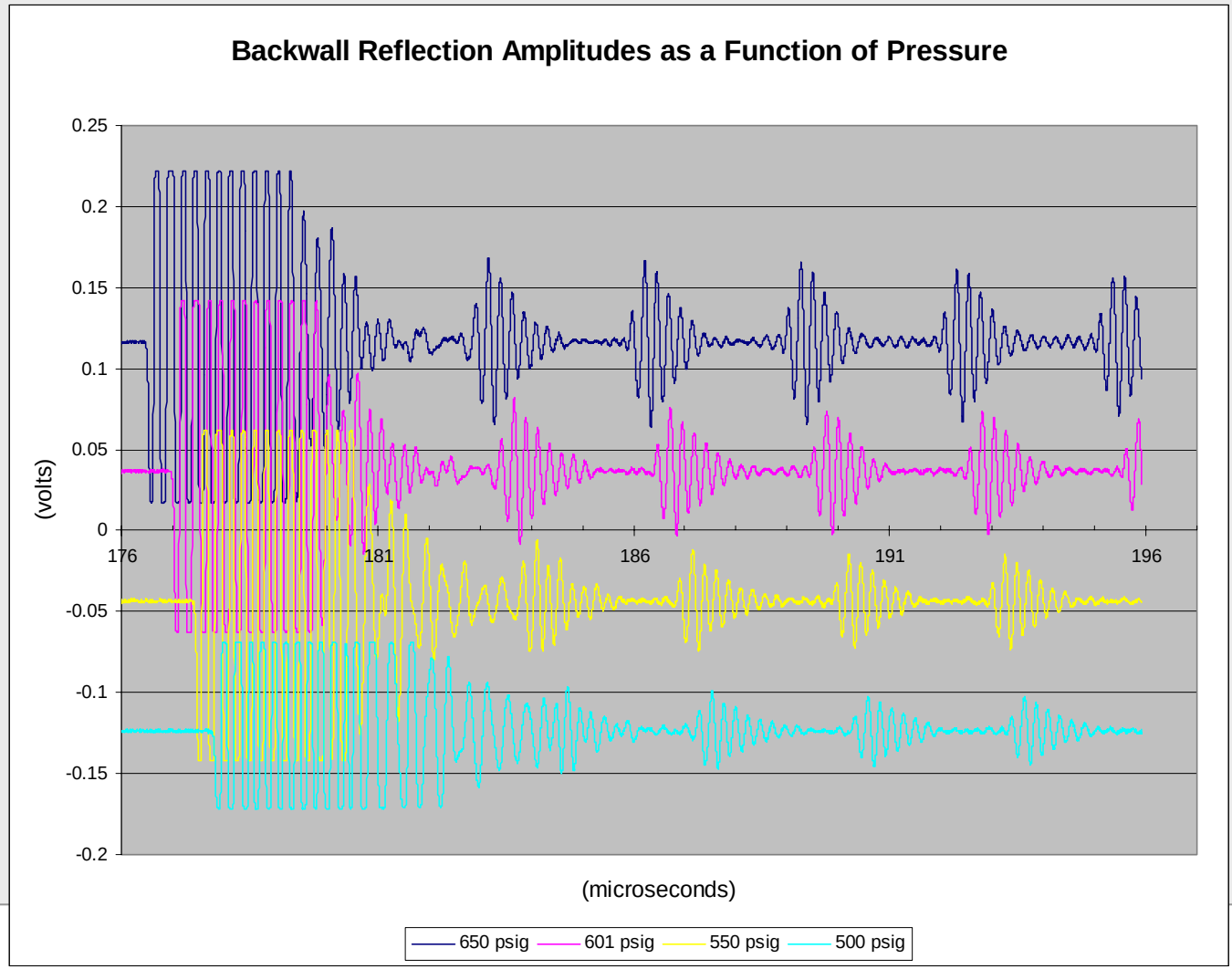

- Reduced sensitivity to material properties
- No liquids or wheels and not sensitive to stand off

# High Pressure Chamber

# Stepped Plate and Transducer



# Results: Ultran #1 – SecondWave



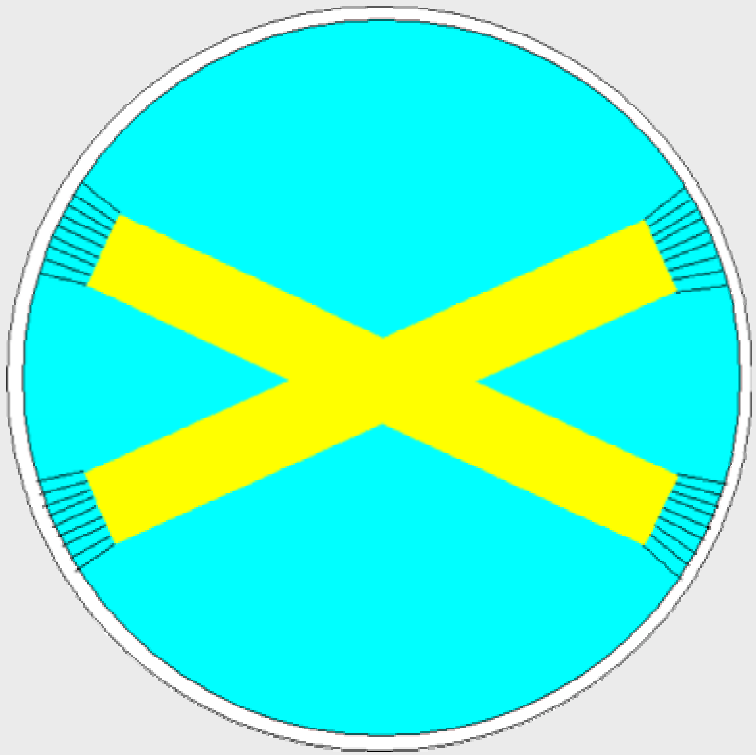
# Current Status

- Test new sensors from SecondWave
- Work with Tuboscope to run the technology in an operating pipeline as a wall thickness measuring device
- Continue sensor development with SecondWave and Weidlinger
- Develop better methods for corrosion measurement
- 2003 start looking at using GCUS for crack detection

gti

# Inspecting for Mechanical Damage

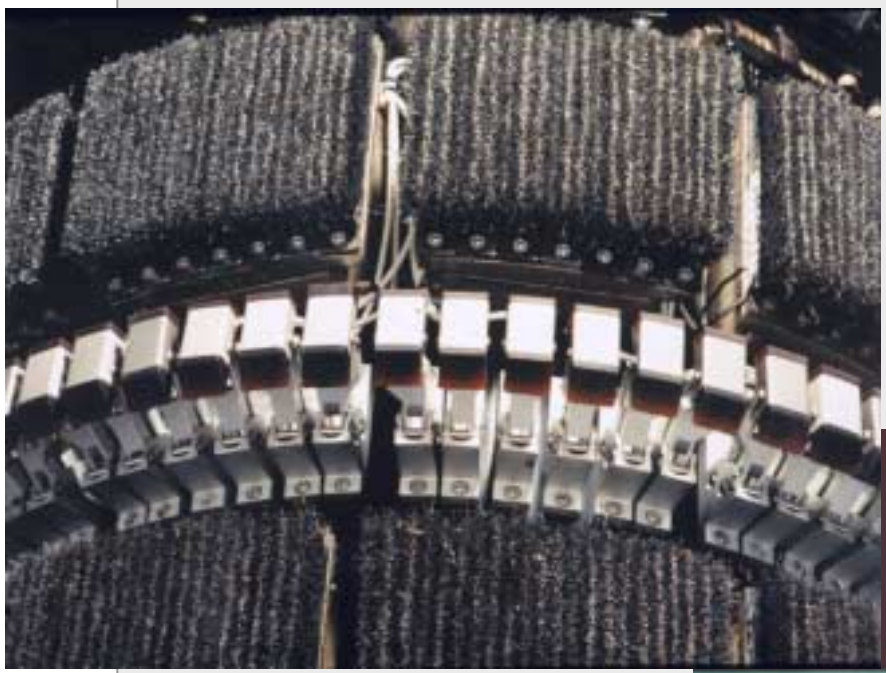
- Signals from standard MFL are inadequate

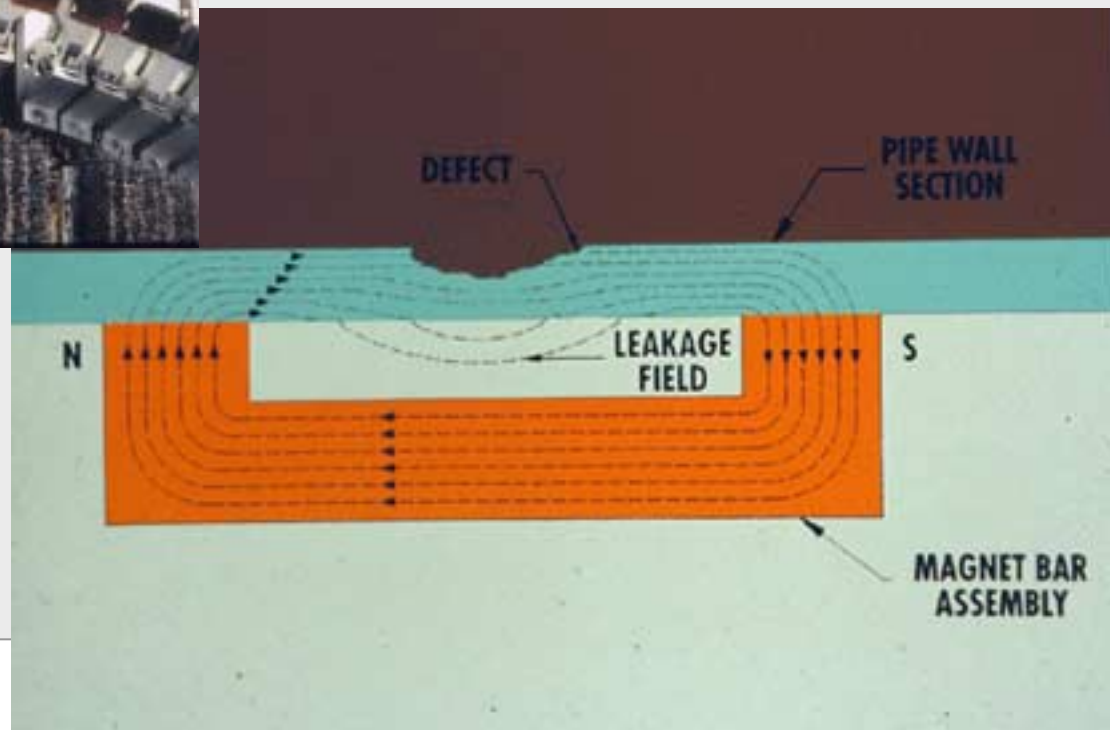


Combine Three Technologies

- Strong field – Weak field
- Circumferential MFL
- Non linear harmonics

# Magnetic Flux Leakage Inspection



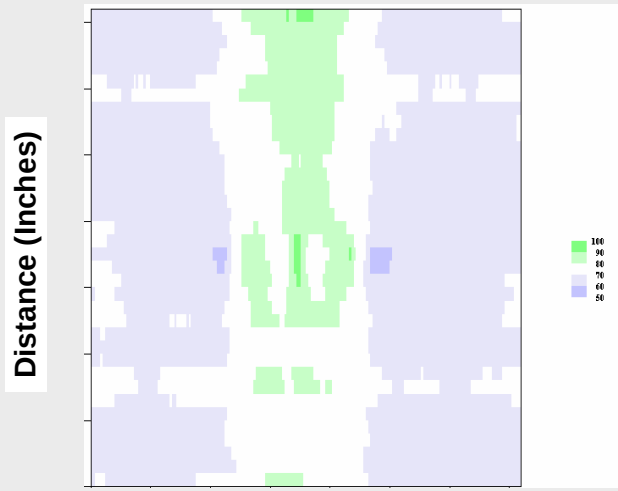


# Magnetic Flux Leakage Inspection

# Circumferential MFL

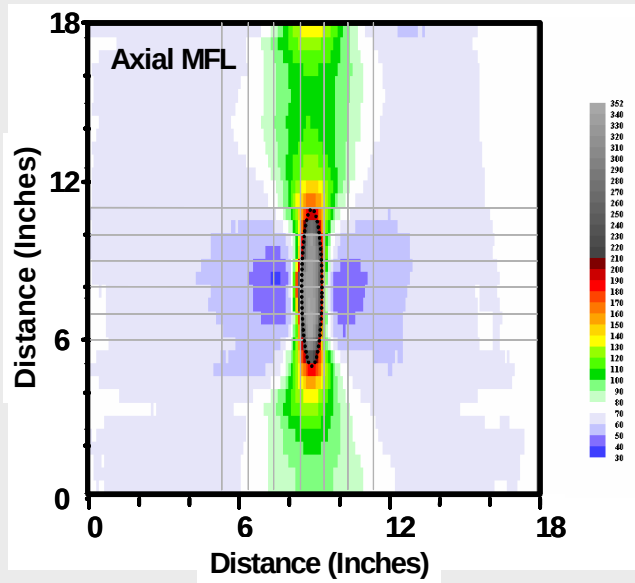
**Defect 69**

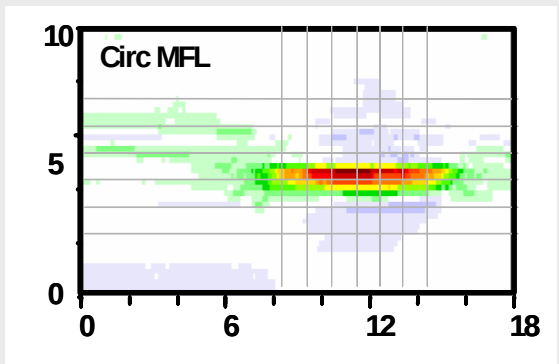
- **50% deep**
- **6 inch long**
- **1 inch wide**

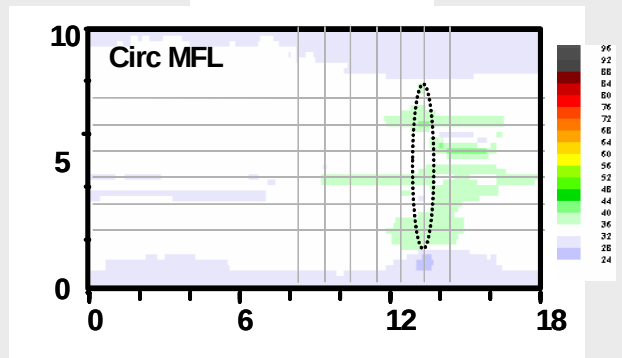



**Defect 45**

- **50% deep**
- **1 inch long**
- **6 inch wide**

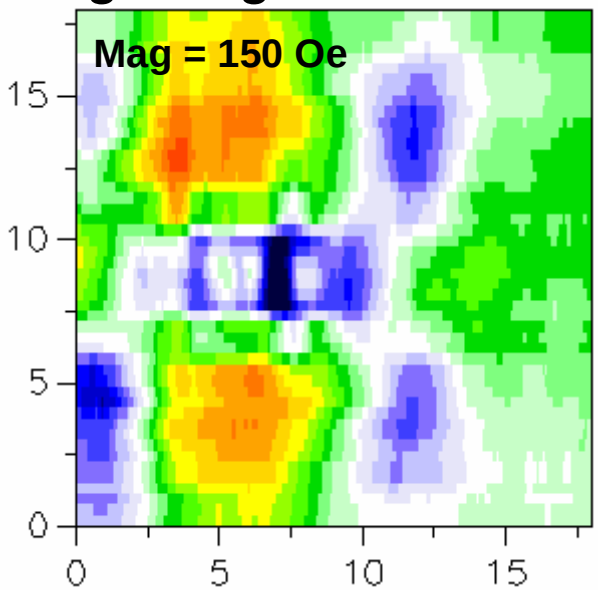


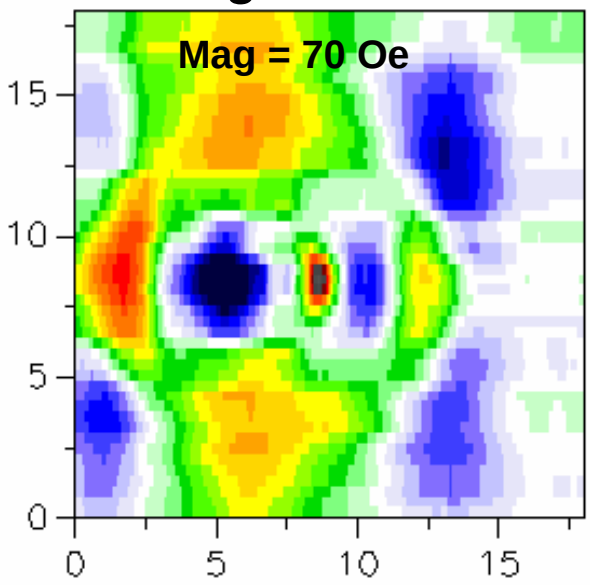



# High-Low Magnetization

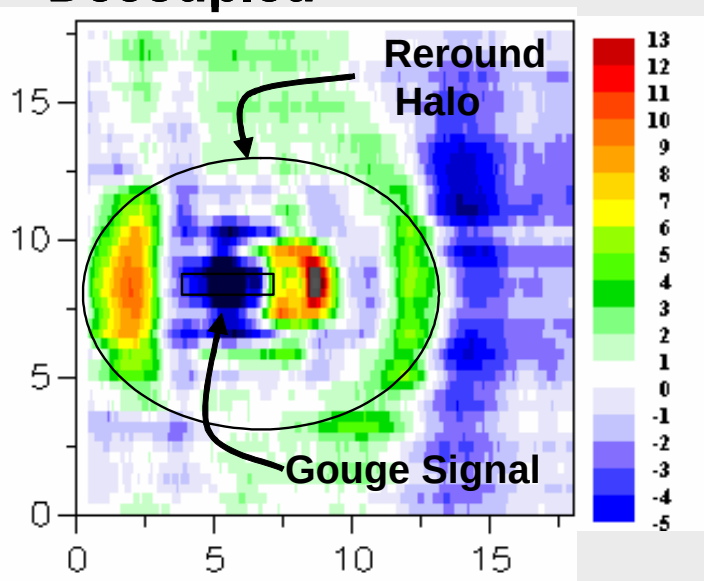
**High Magnetization**



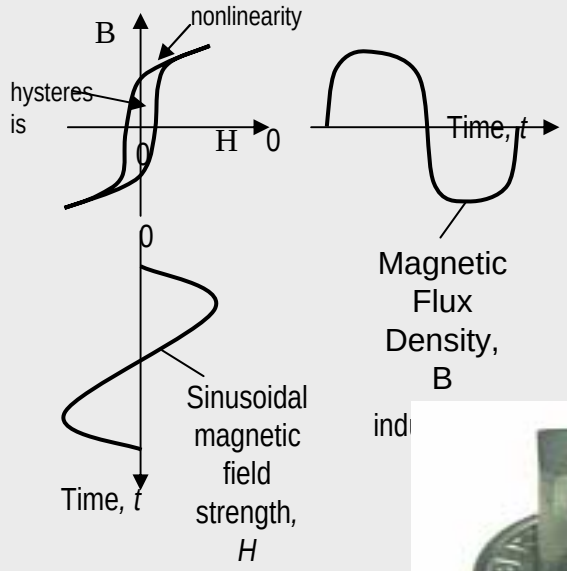

**Low Magnetization**

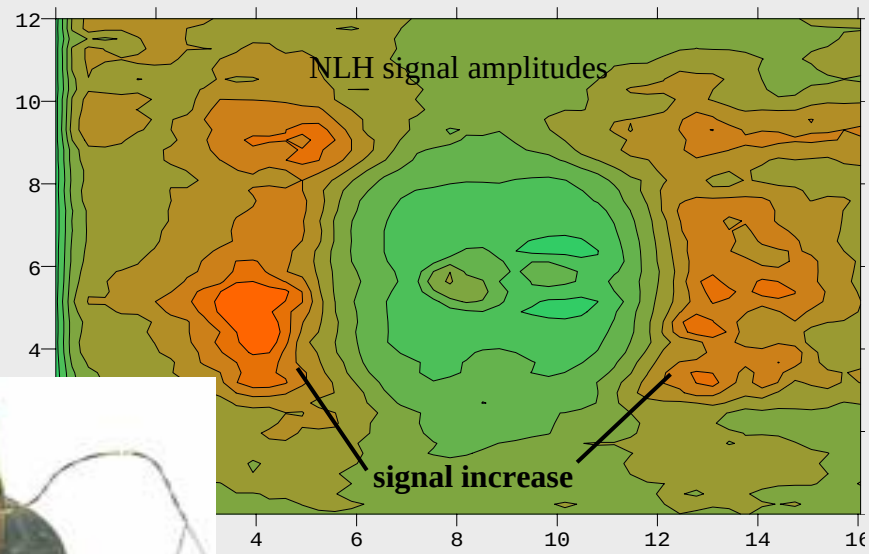


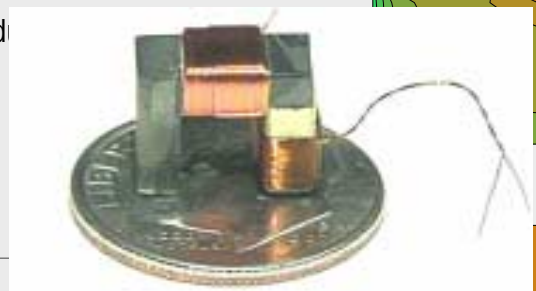

**Decoupled**

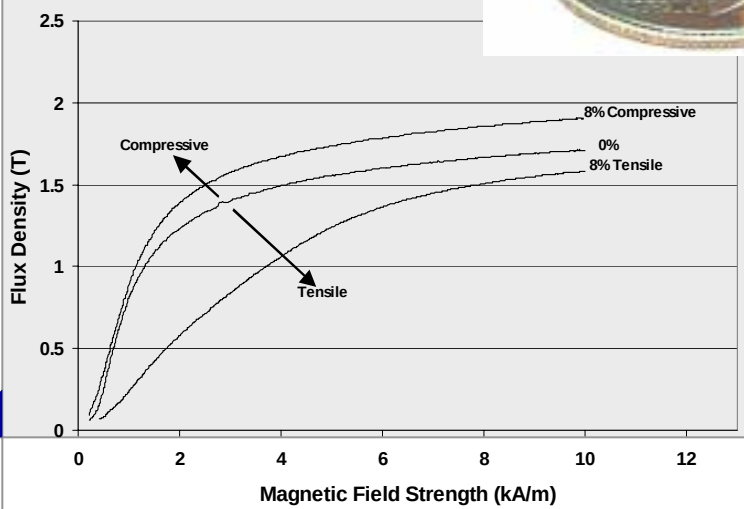


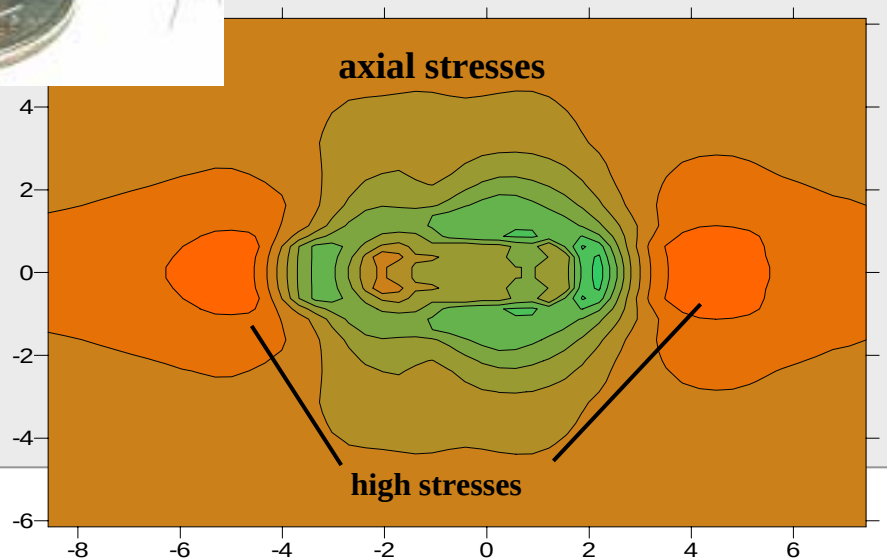
# Non-Linear Harmonics





# Current Status

- Strong – Weak field magnetization has been developed for evaluation for commercialization
- Circumferential magnetization has been developed for evaluation for commercialization
- Non Linear Harmonics needs more development
- Criteria for assessment of mechanical damage have been set out

# Smart Pipe

- Joint project with INEEL
- Measure stress and stress location

- Proved feasibility